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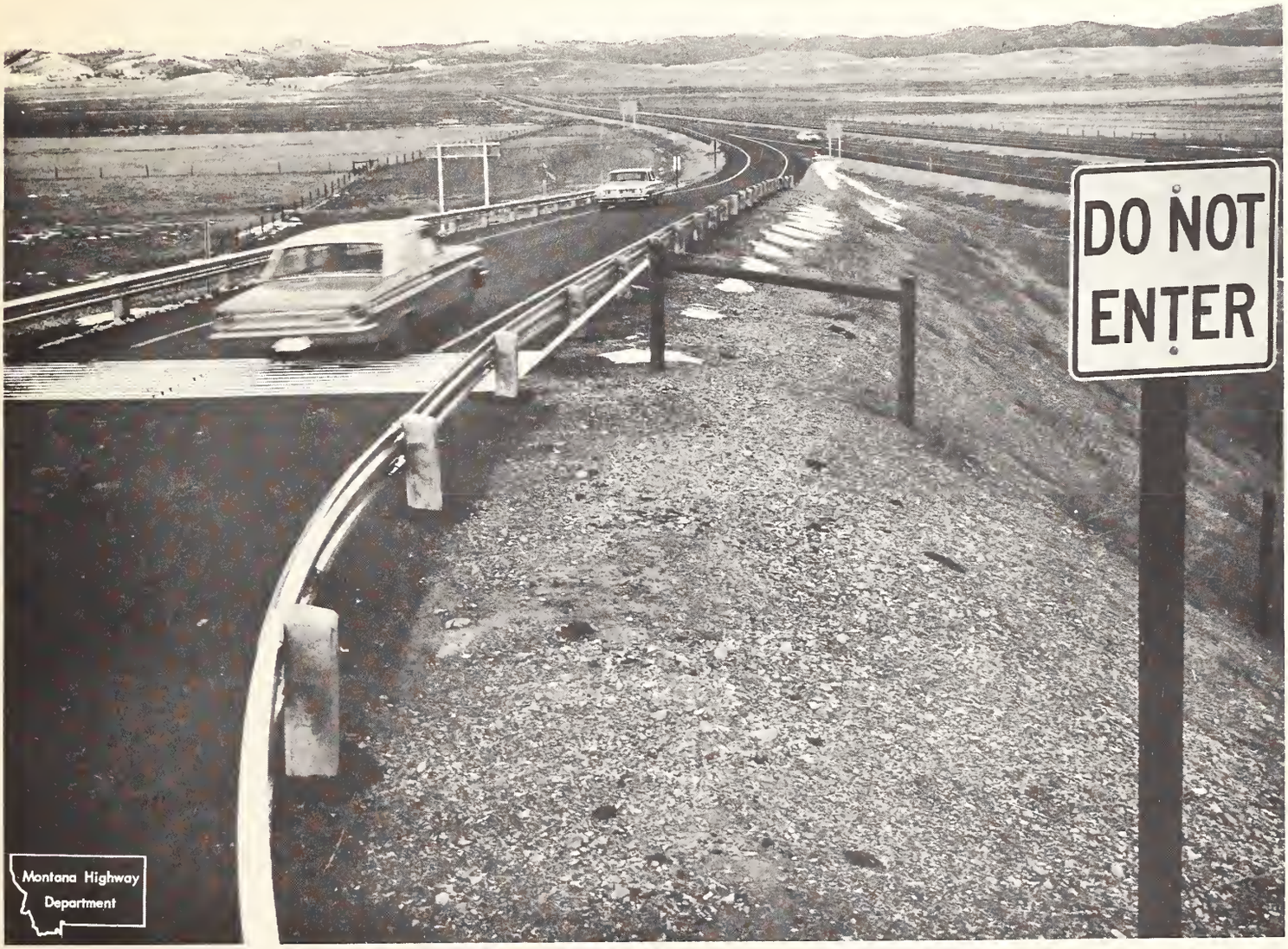
WRONG-WAY RAMP USAGE STUDY



March 1964

Prepared by the
TRAFFIC ENGINEER'S OFFICE
MONTANA STATE HIGHWAY COMMISSION
In co-operation with the
U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

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WRONG-WAY RAMP USAGE STUDY

Report by
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Traffic Engineer's Office

in co-operation with

Planning Survey Department

of the
MONTANA STATE HIGHWAY COMMISSION

and

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

March 1964

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SUMMARY

The Montana State Highway Commission, in cooperation with the U.S. Department of Commerce, Bureau of Public Roads, has completed a two-year study to determine the amount of wrong-way ramp traffic and the accident hazard resulting from wrong-way traffic on interchanges of Montana's 2-lane Interstate highways. The study was conducted during the summers of 1962 and 1963, but the results of the first summer were disregarded due to high counter errors. Six diamond interchanges, two half-diamond interchanges, one partial cloverleaf and one trumpet interchange were studied. The results of the summer of 1963 indicate that:

1. The amount of wrong-way traffic varies from 0.00% to 3.43%, averaging 0.33% of the total ramp traffic.

2. The half-diamond interchanges have the highest overall percentage of wrong-way traffic, while the diamond interchanges have the lowest.

3. The directional signing on the bypass connecting the half diamond interchanges has an effect on the amount of wrong-way traffic on the interchanges.

4. There has not been a reportable accident caused by wrong-way traffic on any of the interchanges included in the study.

From these results, it is apparent that the relatively low amount of wrong-way ramp traffic on Montana's Interstate System does not create any significant accident hazard with the present traffic volumes. They do indicate that future studies on the effect of by-pass signing would be desirable.

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INTRODUCTION

When the Interstate Highway System is completed in Montana, it is estimated that there will be over 80 interchanges on two-lane sections. Shortly after the construction was completed on the first few 2-lane interchanges, it became evident that there was wrong-way traffic on the ramps. The obvious accident potential created by this wrong-way traffic caused the Montana State Highway Commission and the Bureau of Public Roads to research available literature in an effort to determine what past studies have been conducted on this subject. When no previous studies could be located, a research project was set up under the supervision of the Traffic Engineer to determine the actual amount of wrong-way traffic and the hazard that exists from this traffic. The project was financed by the Department of Commerce, Bureau of Public Roads, from Highway Planning Research funds, as part of Project HPR - 1 (2).

This study was conducted during the summers of 1962 and 1963. The first part of the study, which was conducted during the summer of 1962, indicated an overall wrong-way usage of 1.93% of the total ramp traffic. From actual observation throughout the summer, it is believed this value is much too high and is due to counter error. During the summer of 1963, the pressure tubes were reversed on the counter and the results were more comparable to actual observations. The counters recorded 194 wrong-way vehicles out of a total of 59,100 vehicles using the ramps, or 0.33% wrong-way usage during the summer of 1963.

The various ways to incorrectly use each type of two-lane interchange included in this study are shown in Figures 1 through 4. The four types of interchanges included in this study and their locations are listed below:

1. Full Diamond (See Figure 1). Ulm, North Deer Lodge, Baker Road, Broadus Road, Sunburst and Lima.
2. Half Diamond (See Figure 2). Cascade and Wibaux.
3. Partial Cloverleaf (See Figure 3). 902nd Air Force Squadron (Miles City Area).
4. Trumpet (See Figure 4). Monida.

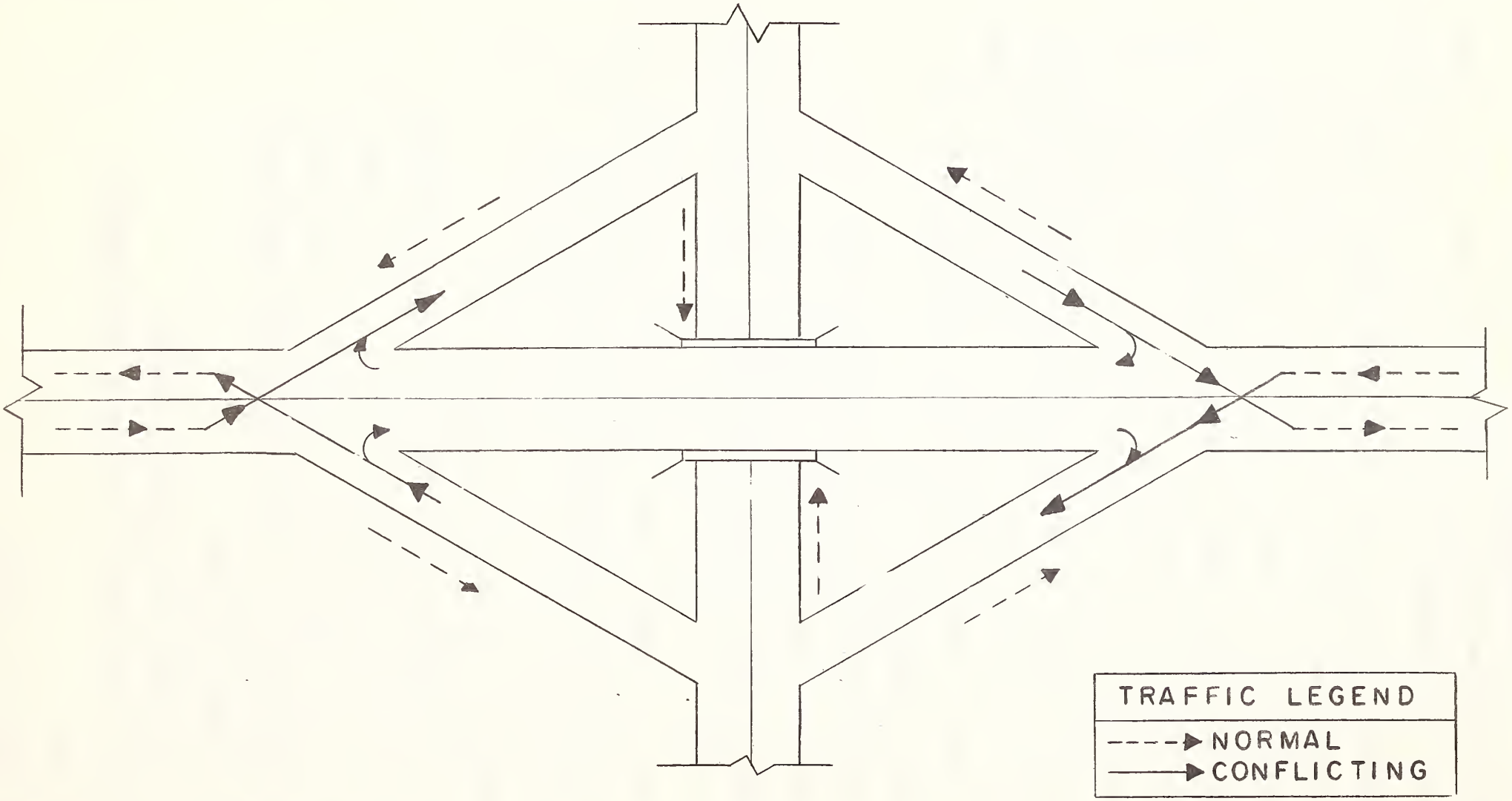


Figure 1

Typical 2-Lane Diamond

Possible conflicting traffic movements pictured

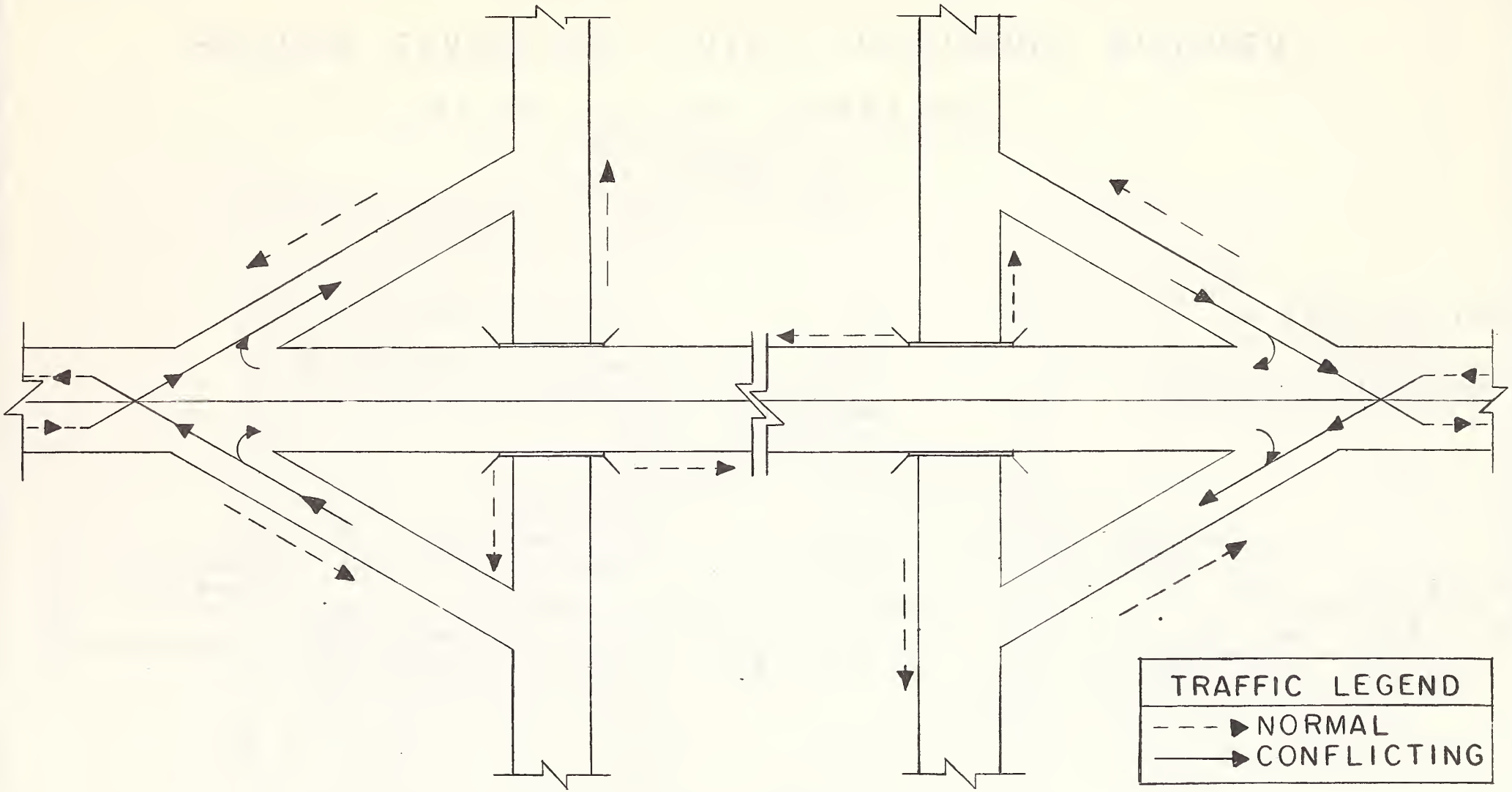


Figure 2

Typical Half Diamond

Possible conflicting traffic movements pictured

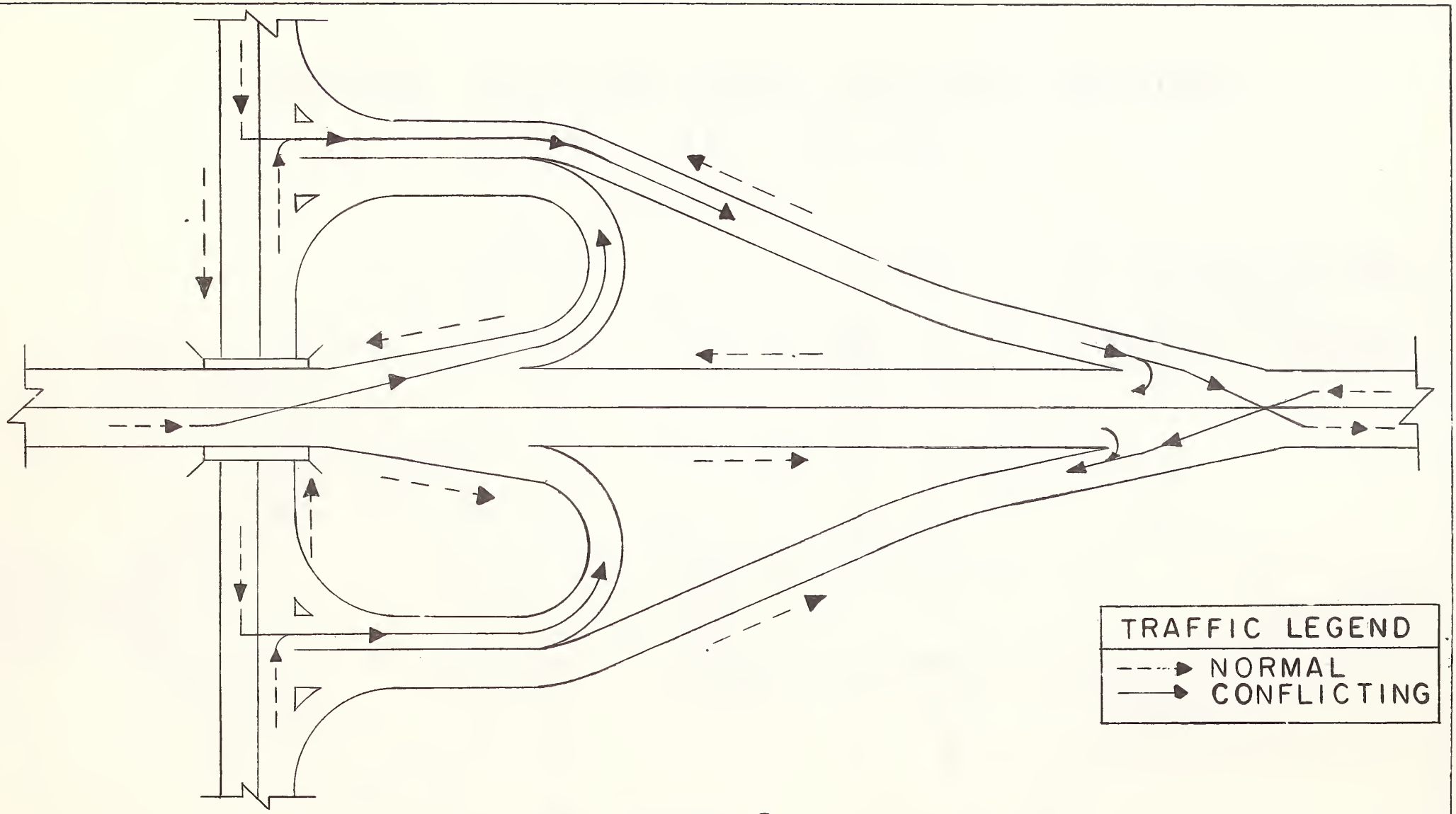


Figure 3

Typical Partial Cloverleaf

Possible conflicting traffic movements pictured

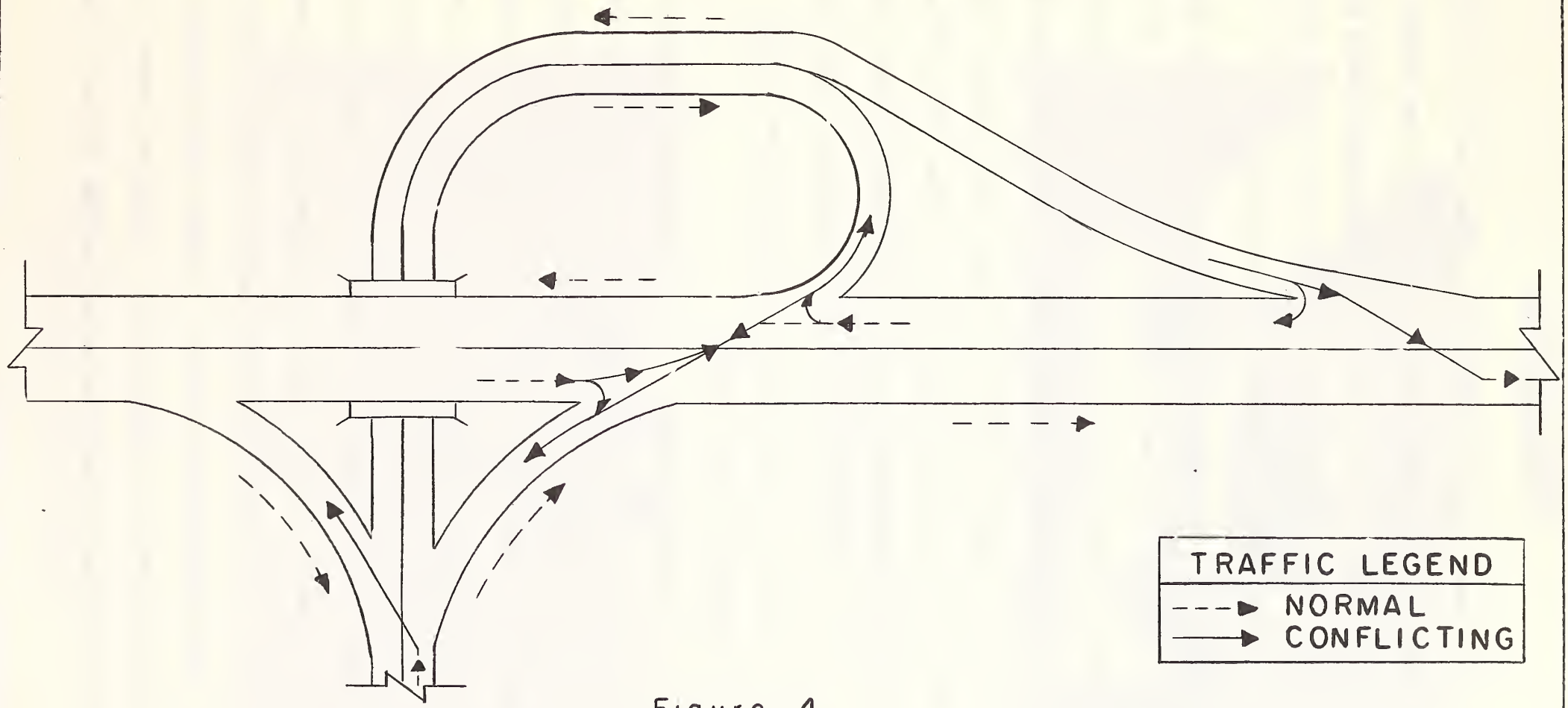


Figure 4

Typical Trumpet

Possible conflicting traffic movements pictured

STUDIES CONDUCTED

LOCATION: During the summer of 1962, traffic surveys were made on the Ulm, North Deer Lodge, Lima, Monida, and Sunburst Interchanges. During the summer of 1963, several interchanges were added to the study. The interchanges added were North and South Cascade, East and West Wibaux, and the Baker Road, Broadus Road and 902nd Air Force Squadron Interchanges in the Miles City area.

EQUIPMENT AND PERSONNEL: Ten directional counters, manufactured by the K-Hill Signal Company, Uhrichsville, Ohio, were purchased for this study. (See Figures 5 and 6). Other equipment includes 600 feet of "Twin" tube and one automobile.

The personnel used were one engineering aide to install and record the data, one engineer to analyze the data and write the report and one typist. During the summer of 1962, 560 man hours were spent recording the data, while 80 man hours were spent analyzing the data and preparing the preliminary progress report. During the summer of 1963, 590 man hours were spent recording the data and 1320 man hours were spent analyzing the data and preparing the final report. A total of 2550 man hours were expended on this project.

PROCEDURE: With the directional counters it is necessary to install only one counter per ramp (See Figure 6). These counters were located on the ramp at least 200' from the cattle guard and on a tangent section if possible. However, when available, two counters per ramp were used to give an indication of counter error. During 1962, total traffic was counted on all interchange ramps for a period of seven days. Each interchange, except Monida and Lima, was studied twice.

During the summer of 1963, each interchange, with the exception of Monida and Lima, was studied for a period of seven days with an additional five days being spent at Ulm and Cascade. The counter data was recorded at least twice daily. Since the counters record axles and not vehicles, traffic classification was conducted on each ramp approximately 4 hours per day. During the summer of 1963 traffic was classified during the nighttime as well as the daytime on each interchange.

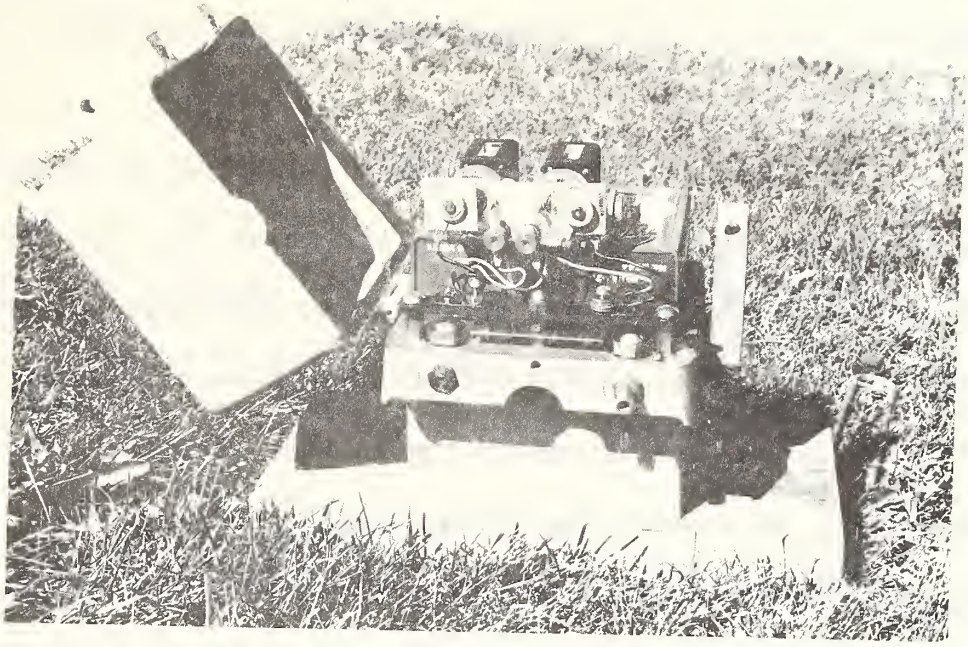


Fig. 5

K-Hill Directional Traffic Counter Showing
the Operating Mechanism

Fig. 6

Typical Installation of the K-Hill
Directional Traffic Counter

Field Data: The actual data, as recorded in the field, are on file in the Traffic Engineer's Office. For a summarization of the 1962 data, see Tables I and II, of the Appendix.

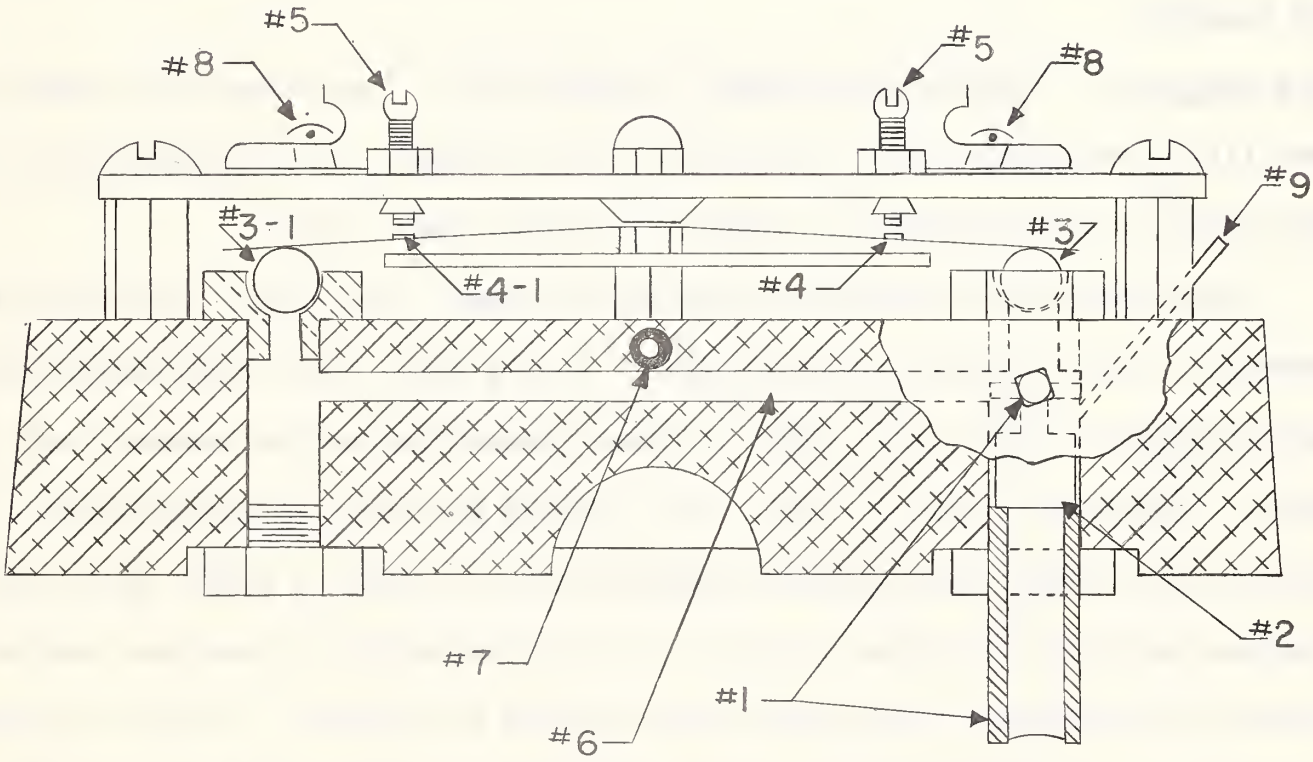
Data Analysis: From the data summary in Table II, it can be seen that there was considerable wrong-way traffic indicated by the counters. The percentage varies from 0.27% to 6.77%, averaging 1.93% of the total ramp traffic. From observations throughout the summer, it was believed that this value of 1.93% wrong-way was much too high. This error was attributed to the counter "chatter", which will be explained along with the operations of the directional counter.

When the flow of the traffic is in one direction, both counter dials register each passing axle. When the flow of traffic is in the opposite direction, only one of the dials registers each passing axle. Figure 5 shows the operating mechanism of the counter, including dials and tube connections.

Figure 7 will be used to explain the operation of the counter. The double tube is placed on the ramp so that right-way traffic first crosses the tube connected to the upper nipple. When the tires of a vehicle hit this tube, air pressure is created in the upper nipple, forcing the cylinder balls (3 & 3-1) up, causing the contact points (4 & 4-1) to register an axle on both dials. Air pressure created in the second tube has no effect at this point because there is equal air pressure present above piston (2), which prevents it from moving up. When a vehicle traveling in the wrong direction on a ramp crosses the tube, air pressure is created in the lower nipple first, forcing the piston (2) up and blocking the air passage to cylinder ball (3). The air entering the upper nipple (1) at this time, activates contact point (4-1) and registers on one dial only. One dial registers wrong-way traffic and both dials register right-way traffic. The total number of wrong-way axles is the difference in readings of the two dials. The total right-way traffic is the lower reading of the two dials. Occasionally air pressure would cause one of the balls to bounce up twice, creating a difference between the two dials and indicating wrong-way traffic when there was none. This effect is known as counter "chatter".

FIG. 7

SCHEMATIC DIAGRAM OF INTERNAL PARTS OF A K-HILL DIRECTIONAL TRAFFIC COUNTER



#1- TUBE NIPPLES
#2- PISTON
#3- CYLINDER BALLS
#4- CONTACT POINTS
#5- CONTACT SCREWS
#6- AIR PASSAGE
#7- CONTACT POST SET SCREW
#8- ELECTRICAL CONNECTIONS
#9- AIR RELEASE STEM

At the end of the summer of 1962, the pressure tubes were reversed in an effort to reduce the "chatter" effect of the counters. Connecting the tubes in this manner records the right-way traffic on one dial and wrong-way traffic on both dials. Further experiments conducted during the spring of 1963 proved that this procedure would yield more accurate results.* This doesn't eliminate "chatter", but the "chatter" from right-way vehicles will have very little effect on the wrong-way dial.

DATA - SUMMER 1963

Field Data: The actual data, as recorded in the field, are on file in the Traffic Engineer's Office. For a summarization of the 1963 data, see Tables III and IV, in the Appendix.

Data Analysis: From the data summary in Table IV, it can be seen that there was very little wrong-way traffic indicated by the counters. Percentage-wise, it varied from 0.00% to 3.43%, averaging 0.33% of the total ramp traffic.

While classifying traffic throughout the summer, the actual observed traffic was compared to the recorded counter traffic. During these hours 5,883 axles were observed going over the tubes, while the total registered on the counters was 5,990 axles. This is an error of 1.82%. Also, during the hours of classification, six vehicles (12 axles) were observed wrong-way out of 5,883, or 0.20%, while the counters registered 14 axles, or .23%. It is interesting to note that during the periods of observation the counters never failed to register a vehicle traveling wrong-way. It is reasonable to assume that there is less wrong-way traffic than indicated by the counters.

During the summer, several factors were discovered that caused error in the results:

1. Some people back over these tubes, not knowing the tubes are directional. This was observed several times during the summer.
2. If the piston doesn't block the air passage in time, it will register wrong-way.

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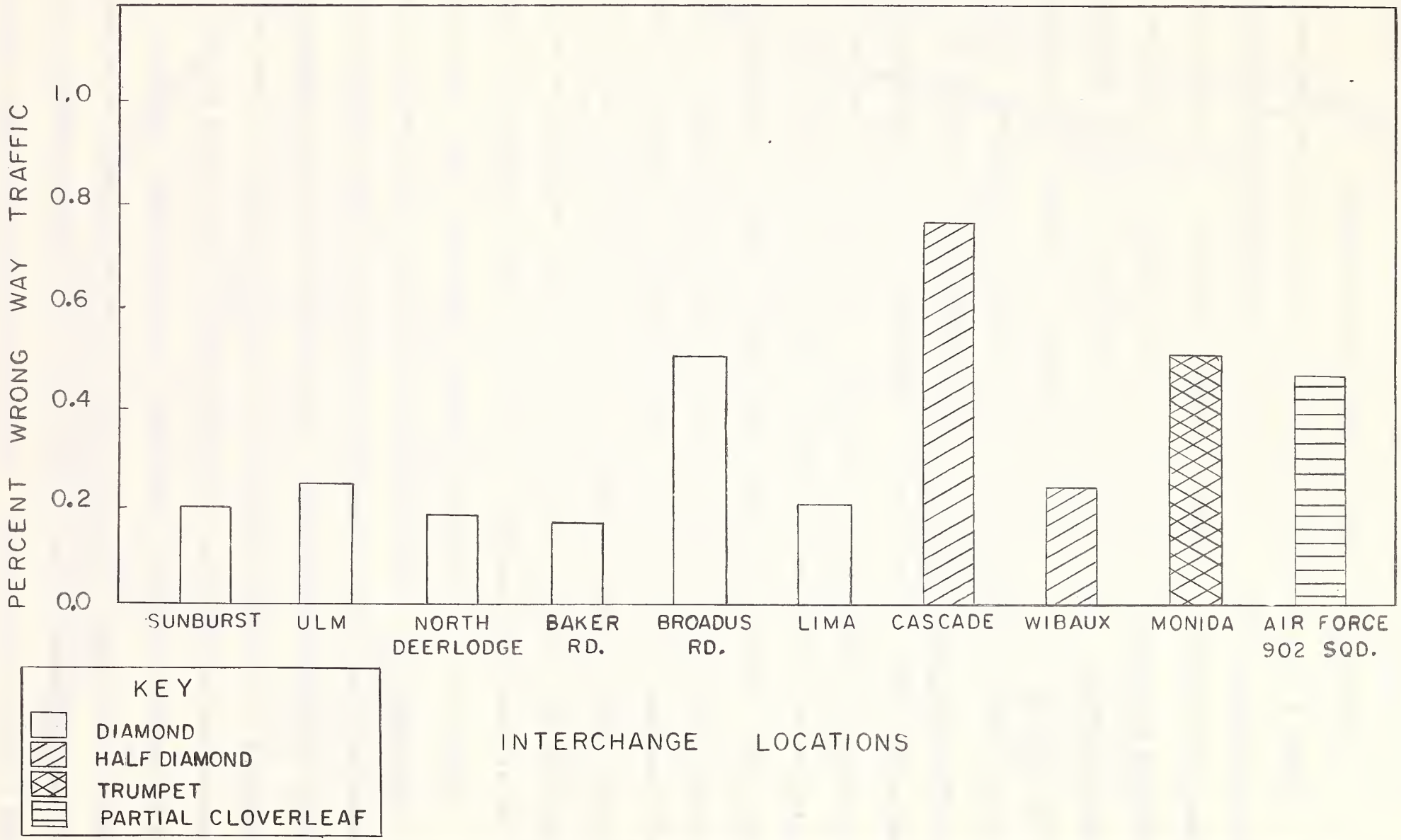
* Traffic Engineer's office, Montana State Highway Commission, Wrong Way Traffic Study 2-4 Lane Concrete-Asphalt Transition; February, 1964.

FIG. 8

PERCENT WRONG WAY TRAFFIC BY INTERCHANGES



3. If a vehicle suddenly stops it will cause the tube to turn over and, consequently, record the next axle as wrong-way.

Figure 8 is a bar graph by which one can easily compare the wrong-way usage at each interchange studied. An interesting comparison is the two half diamonds at Cascade and the two half diamonds at Wibaux. The half diamonds at Cascade have the highest percentage of wrong-way traffic, while the half dimaonds at Wibaux are one of the lower percentages. Figures 9 and 10 are city plats of Cascade and Wibaux, respectively, showing the half diamond interchanges. In Wibaux, the business section of town is located on Montana Route #7 and, therefore, most of the traffic leaving town enters the Interstate via the Junction of Montana #7 and US #10. At this intersection there are route markers indicating I 94 East and West, thus making it very clear how to get onto the Interstate. In Cascade, the business section is located on both US #91 and FAS 330, but there were no Interstate route markers on either road. Personal interviews conducted with the local businessmen indicated that the tourists were confused and were looking for some type of signing which would show them how to get back to the Interstate. It can be reasonably assumed that the lack of signing at Cascade is a cause of the large amount of wrong-way traffic at this location. Interstate route markers are going to be installed on US #91 at Cascade in an effort to reduce the amount of wrong-way traffic.

Figure 11 is a bar graph, showing a comparison of the total wrong-way traffic by interchange type. From this graph it can be seen that the half diamond interchanges have the highest percentage of wrong-way traffic, followed closely by the trumpet and partial cloverleaf. The full diamond type interchange has the lowest percentage of wrong-way traffic of all the types studied. Before any valid conclusions can be drawn from this graph, one must keep in mind that only one trumpet and one partial cloverleaf interchange have been studied, compared to six full diamond interchanges. The only trumpet interchange studied is at Monida. During the seven day period it was studied, only four wrong-way vehicles were recorded from a total of 799 or 0.50%. Of the four wrong-way vehicles, three were recorded during one night, which would lead one to believe this is rather unusual, consider-

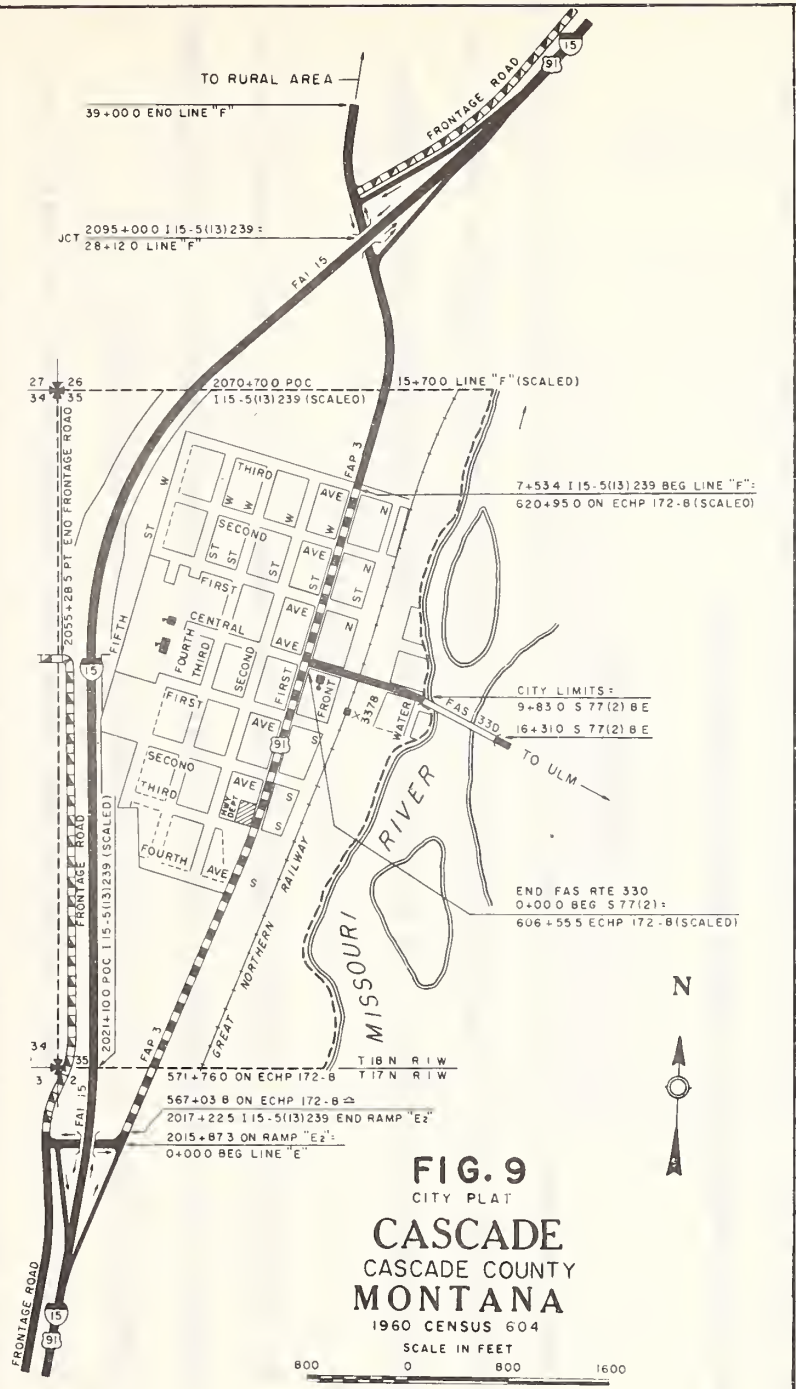


FIG. 9
CITY PLAT
CASCADE
CASCADE COUNTY
MONTANA
1960 CENSUS 604
SCALE IN FEET
800 0 800 1600

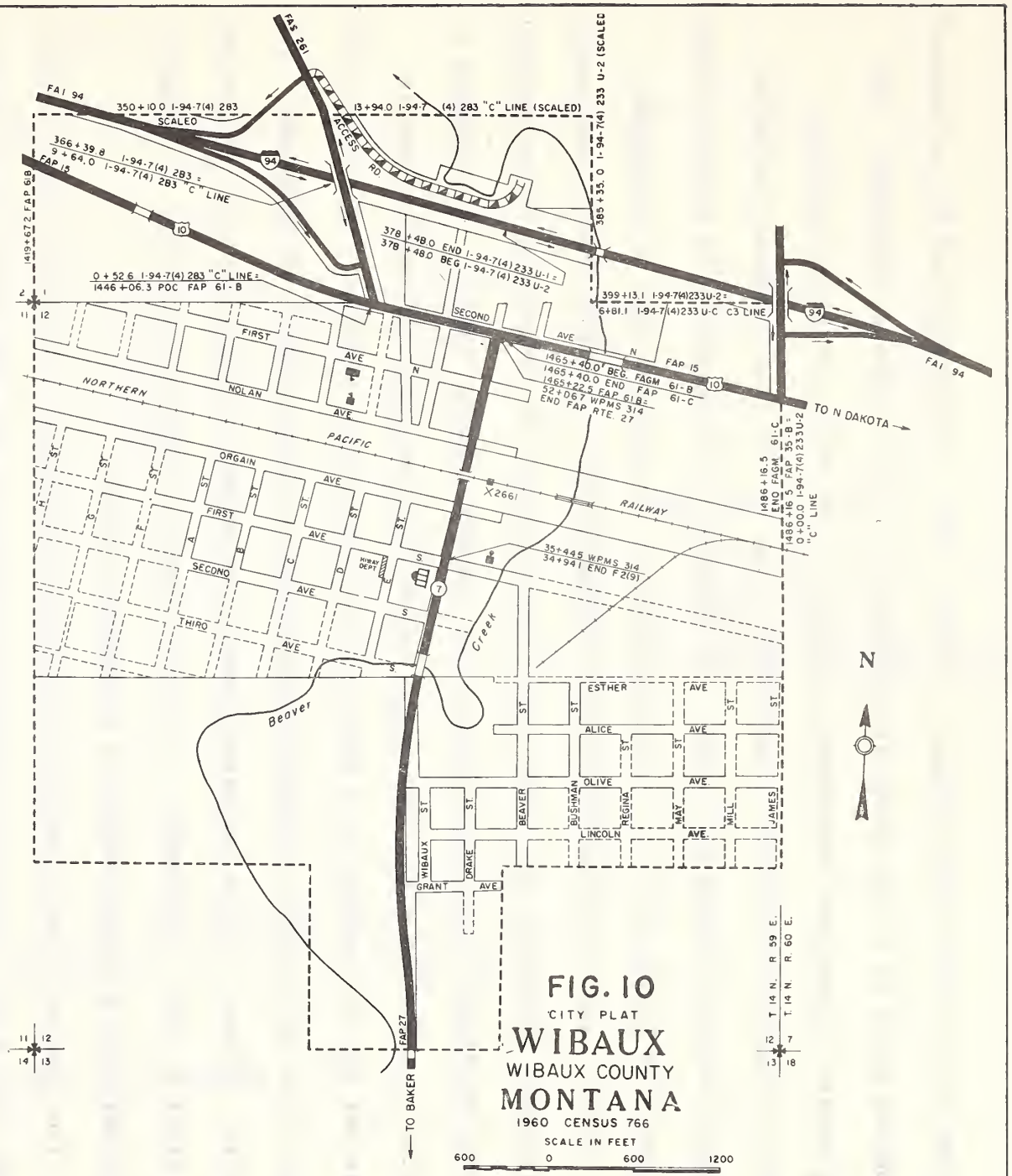


FIG. 10
CITY PLAT
WIBAUX
WIBAUX COUNTY
MONTANA
1960 CENSUS 766
SCALE IN FEET
600 0 600 1200

ing the total traffic was average. If these three were disregarded the percent of wrong-way would be 0.13%, which is comparable to the diamond interchanges. The only partial cloverleaf interchange studied is the 902nd Air Force Squadron. During the seven day period it was studied, six of the nine wrong-way vehicles recorded occurred during one night. If these were disregarded, the percent wrong-way would be 0.16%, which is also comparable to the diamond type interchanges.

In the case of the half diamond interchanges the wrong-way traffic was evenly distributed throughout the study period and there was no indication of any unusually high readings that would influence the results. Table V is a classification of traffic into day and night time usage. Note that the night studies include 16 hours per day as compared to 8 hours per day for the day studies. It can be seen there is no appreciable difference between day or night percent of wrong-way traffic. Figure 12 is a bar graph showing the number of wrong-way vehicles by day and night at each interchange. It can be seen that the half diamonds at Cascade again have the greatest amount of wrong-way traffic.

The possibilities of making a statistical analysis of this data were investigated, but due to the lack of sufficient data, it was decided this study didn't warrant the additional expense and time required.

CONCLUSIONS

From the data analysis of the summer of 1962 there was indication of considerable wrong-way traffic, but as pointed out in the "Preliminary Progress Report of Wrong-Way Ramp Use Study", the accuracy of this data is protested due to counter error.

By reversing the pressure tubes during the summer of 1963, the counter error was reduced and, consequently, more accurate results were obtained. From the 1963 data analysis there is very little indication of wrong-way traffic.

Results of this study indicate that some study of the effect on traffic of By-Pass signing is desirable. The signing on the By-Pass of half diamond inter-

FIG. 11

TOTAL PERCENT WRONG WAY TRAFFIC BY INTERCHANGE TYPE

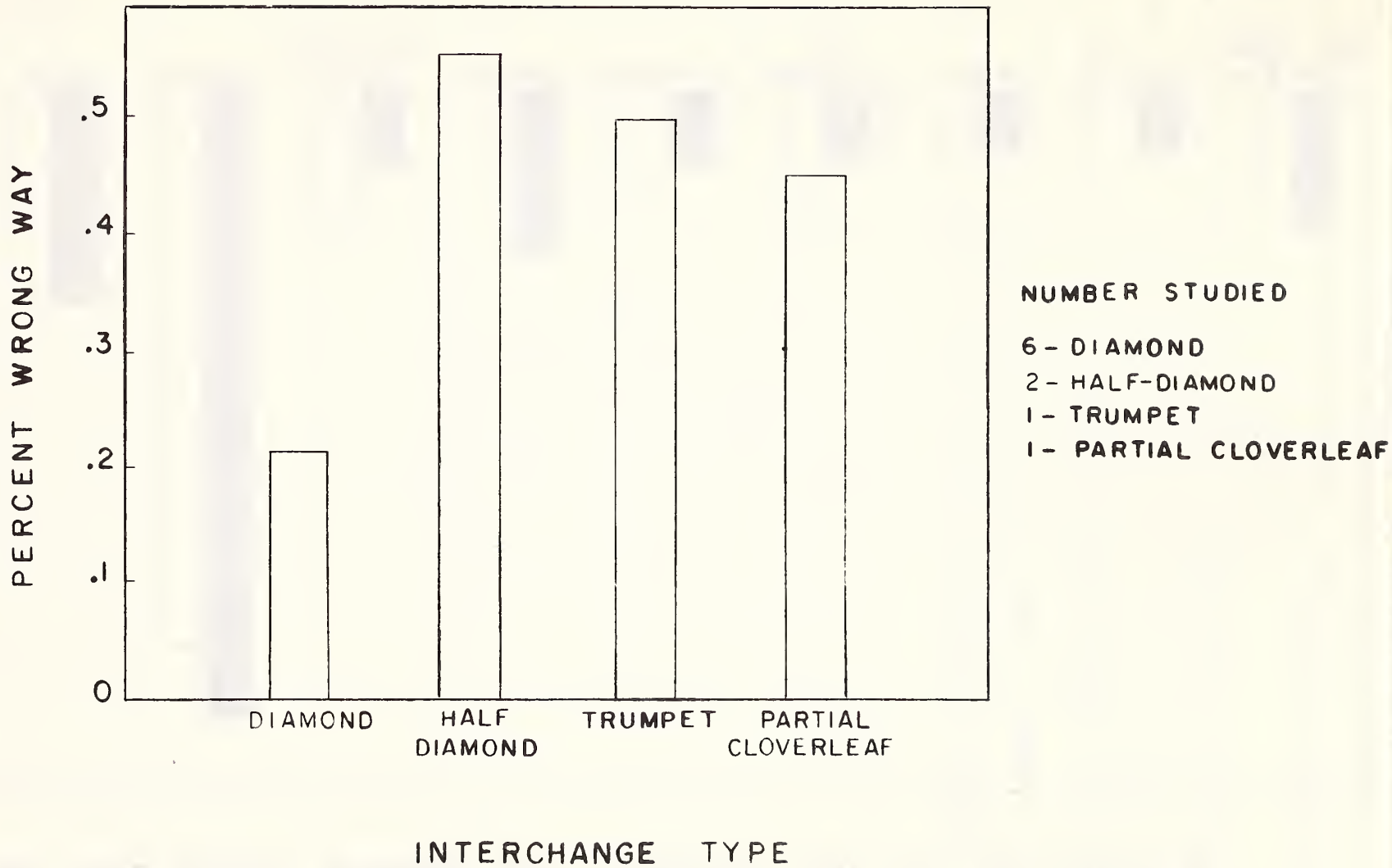
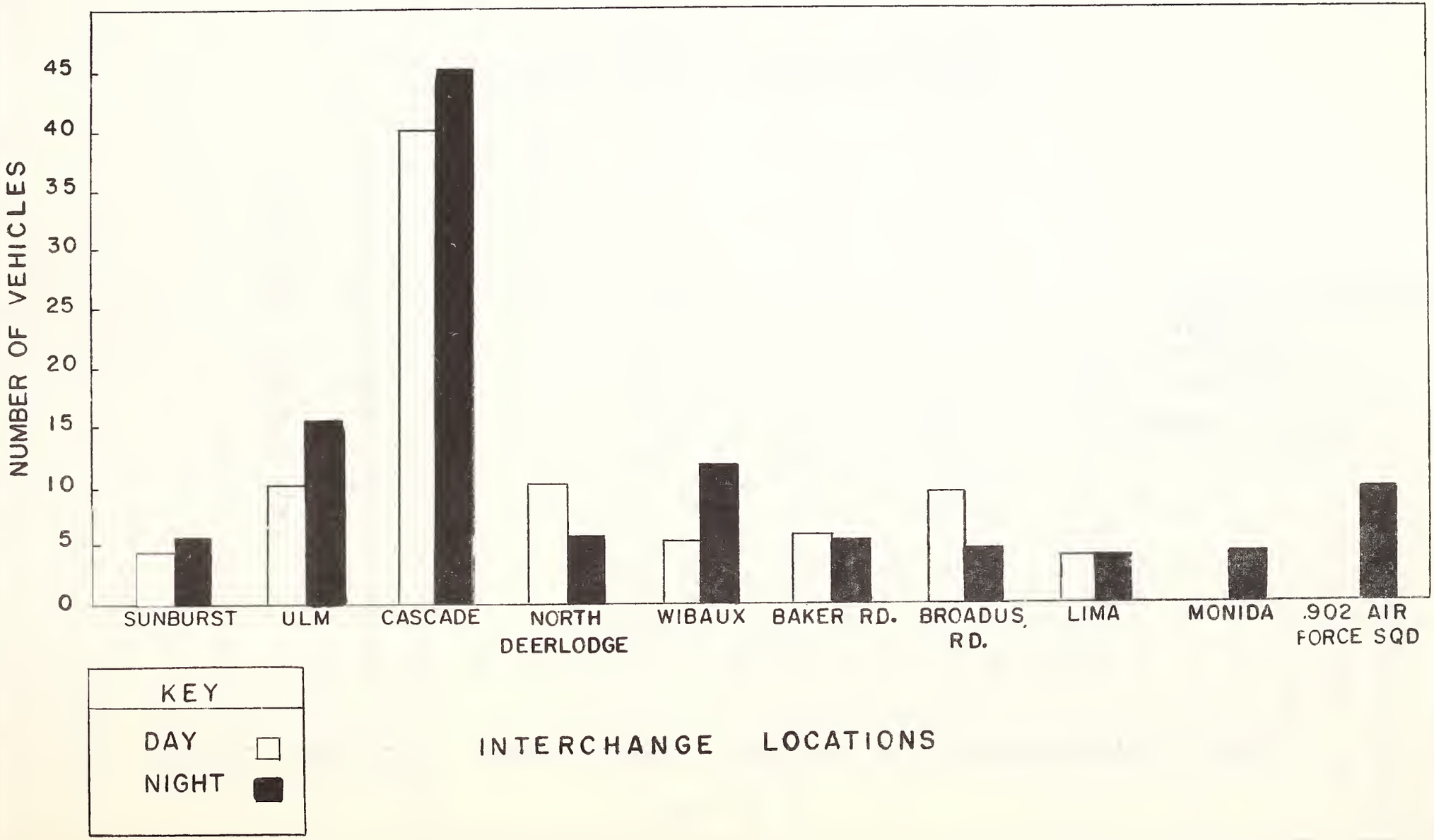


FIG. 12

DAY AND NIGHT WRONG WAY TRAFFIC ON INTERCHANGES



changes appears to have an influence on the amount of wrong-way traffic, but due to the limited number studied, this is not conclusive.

A review of all previous accident reports revealed there has not been a reportable accident, due to wrong-way traffic on any of the interchanges included in the study. With the low volume of traffic on Montana highways and the relatively low amount of wrong-way traffic indicated by this study, it appears that there is no significant accident hazard on the two-lane interchanges in Montana.

APPENDIX

Table I: Summary of Traffic Classification Data - 1962.

Table II: Summary of Wrong-Way Traffic Data as Recorded From Counters - 1962.

Table III: Summary of Traffic Classification Data - 1963.

Table IV: Summary of Wrong-Way Traffic Data as Recorded From Counters - 1963.

Table V: Day and Night Percent Wrong-Way Traffic - 1963.

TABLE I: SUMMARY OF TRAFFIC CLASSIFICATION DATA - 1962

			RAMP				
DATE	LOCATION	TIME	FROM	TO	AXLES	VEHICLES	AXLE/VEHICLE
6/28/62	Ulm	8 hours	Great Falls	Ulm	348	170	2.047
"	"	"	Ulm	Cascade	77	33	2.333
"	"	"	Cascade	Ulm	46	22	2.091
"	"	"	Ulm	Great Falls	398	145	2.041
7/12/62	N. Deer Lodge	"	Deer Lodge	Butte	80	40	2.000
"	"	"	Butte	Deer Lodge	42	21	2.000
"	"	"	Deer Lodge	Garrison	744	350	2.126
"	"	"	Garrison	Deer Lodge	726	341	2.129
7/28/62	Lima	"	Lima	Dillon	145	72	2.014
"	"	"	Dillon	Lima	142	70	2.029
"	"	"	Lima	Idaho	97	47	2.064
"	"	"	Idaho	Lima	99	49	2.020
7/29/62	Monida	"	Dillon	Monida	41	19	2.159
"	"	"	Monida	Idaho	17	8	2.125
"	"	"	Idaho	Monida	25	12	2.083
"	"	"	Monida	Dillon	50	24	2.083
8/8/62	Sunburst	"	Sunburst	Shelby	246	120	2.050
"	"	"	Shelby	Sunburst	258	127	2.031
"	"	"	Sunburst	Canada	155	75	2.067
"	"	"	Canada	Sunburst	130	63	2.063

TABLE II: SUMMARY OF WRONG-WAY TRAFFIC DATA AS

RECORDED FROM COUNTERS - 1962

		RAMP		TOTAL AXLE COUNT		AXLE/VEH. RATIO		TOTAL VEHICLES		*PER CENT WRONG-WAY VEHICLES
DATE	LOCATION	FROM	TO	RIGHT	WRONG	RIGHT	WRONG	RIGHT	WRONG	
6/28-7/4	Ulm	Great Falls	Ulm	4890	25	2.047	2.000	2389	13	0.54
"	"	Ulm	Cascade	966	10	2.333	"	414	5	1.21
"	"	Cascade	Ulm	1199	30	2.091	"	573	15	2.62
"	"	Ulm	Great Falls	4923	29	2.041	"	2412	15	0.62
8/16-8/23	"	Great Falls	Ulm	6523	61	2.047	"	3187	31	0.97
"	"	Ulm	Cascade	2569	26	2.333	"	1101	13	1.18
"	"	Cascade	Ulm	2588	69	2.091	"	1238	35	2.83
"	"	Ulm	Great Falls	6893	43	2.041	"	3377	22	0.65
7/11-7/18	N. Deer Lodge	Deer Lodge	Butte	1213	34	2.000	"	607	17	2.80
"	"	Butte	Deer Lodge	709	6	2.000	"	355	3	0.85
"	"	Deer Lodge	Garrison	10827	357	2.126	"	5093	178	3.49
"	"	Garrison	Deer Lodge	9292	120	2.129	"	4364	60	1.37
8/27-9/2	"	Deer Lodge	Butte	663	10	2.000	"	332	5	1.51
"	"	Butte	Deer Lodge	364	8	2.000	"	182	4	2.20
"	"	Deer Lodge	Garrison	7663	127	2.126	"	3603	64	1.78
"	"	Garrison	Deer Lodge	6663	424	2.129	"	3130	212	6.77
7/23-7/30	Lima	Lima	Dillon	2118	9	2.014	"	1052	5	0.48
"	"	Dillon	Lima	2216	5	2.029	"	1092	3	0.27
"	"	Lima	Idaho	1320	15	2.064	"	640	8	1.25
"	"	Idaho	Lima	1225	6	2.020	"	606	3	0.50
7/23-7/30	Monida	Dillon	Monida	601	6	2.159	2.000	278	3	1.08
"	"	Monida	Idaho	258	8	2.125	"	121	4	3.31
"	"	Idaho	Monida	348	6	2.083	"	167	3	1.80
"	"	Monida	Dillon	496	8	2.083	"	238	4	1.68
8/2-8/9	Sunburst	Sunburst	Shelby	3073	17	2.050	"	1499	9	0.60
"	"	Shelby	Sunburst	2950	9	2.031	"	1452	5	0.34
"	"	Sunburst	Canada	1853	26	2.067	"	896	13	1.45
"	"	Canada	Sunburst	1783	30	2.063	"	864	15	1.74
9/6-9/12	"	Sunburst	Shelby	2817	43	2.050	"	1374	22	1.60
"	"	Shelby	Sunburst	2821	73	2.031	"	1389	37	2.66
"	"	Sunburst	Canada	1487	25	2.067	"	719	13	1.81
"	"	Canada	Sunburst	1467	73	2.063	"	711	37	5.20
TOTAL								45455	876	1.93

*These percentages are high due to counter errors. These were corrected during 1963.

TABLE III: SUMMARY OF TRAFFIC CLASSIFICATION DATA - 1963

DATE	LOCATION	TIME Hours	RAMP FROM	RAMP TO	AXLES	VEHICLES	AXLE/VEHICLE
6/11/63	Ulm	23.5	Great Falls	Ulm	759	377	2.01
to	"	"	Ulm	Cascade	102	50	2.04
6/18/63	"	"	Cascade	Ulm	150	72	2.08
	"	"	Ulm	Great Falls	664	328	2.02
8/28/63	Ulm	5	Great Falls	Ulm	247	121	2.04
to	"	"	Ulm	Cascade	45	22	2.05
9/3/63	"	"	Cascade	Ulm	31	15	2.07
	"	"	Ulm	Great Falls	157	76	2.07
6/19/63	Cascade	11.5	Ulm	Cascade	364	174	2.09
to	"	11.5	Cascade	Ulm	467	224	2.09
6/26/63	"	10.0	Cascade	Helena	159	76	2.09
	"	10.0	Helena	Cascade	203	97	2.09
8/28/63	Cascade	6	Ulm	Cascade	332	159	2.09
to	"	6	Cascade	Ulm	233	116	2.01
9/3/63	"	7.5	Cascade	Helena	158	77	2.05
	"	7.5	Helena	Cascade	211	102	2.07
6/28/63	N. Deer Lodge	20	Deer Lodge	Butte	172	81	2.12
to	"	"	Butte	Deer Lodge	86	41	2.10
7/6/63	"	"	Deer Lodge	Garrison	1509	711	2.12
	"	"	Garrison	Deer Lodge	1458	700	2.08
7/12/63	Wibaux	14	Wibaux	Beach	390	180	2.17
to	"	"	Beach	Wibaux	309	150	2.06
7/19/63	"	"	Wibaux	Glendive	642	287	2.24
	"	"	Glendive	Wibaux	527	247	2.13
7/20/63	Baker Road	17.5	Miles City	Billings	278	111	2.50
to	"	"	Billings	Miles City	229	101	2.27
7/27/63	"	"	Miles City	Glendive	785	360	2.18
	"	"	Glendive	Miles City	712	328	2.17
7/20/63	Broadus Road	12	Miles City	Billings	83	37	2.24
to	"	"	Billings	Miles City	141	67	2.10
7/27/63	"	"	Miles City	Glendive	147	68	2.16
	"	"	Glendive	Miles City	157	69	2.28
6/3/63	Sunburst	12	Sunburst	Shelby	349	169	2.06
to	"	"	Shelby	Sunburst	304	146	2.08
6/10/63	"	"	Sunburst	Canada	183	88	2.08
	"	"	Canada	Sunburst	191	94	2.03
8/20/63	Monida	8.5	Lima	Monida	55	27	2.04
to	"	"	Monida	Idaho	26	11	2.36
8/22/63	"	"	Idaho	Monida	20	9	2.22
	"	"	Monida	Lima	43	21	2.05
8/18/63	Lima	15	Lima	Dillon	241	117	2.06
to	"	"	Dillon	Lima	291	144	2.02
8/22/63	"	"	Lima	Idaho	164	81	2.03
	"	"	Idaho	Lima	130	64	2.03

TABLE IV: SUMMARY OF WRONG-WAY TRAFFIC DATA
AS RECORDED FROM COUNTERS - 1963

		RAMP		TOTAL AXLE COUNT		AXLE/VEH. RATIO		TOTAL VEHICLES		PER CENT WRONG-WAY
DATE	LOCATION	FROM	TO	RIGHT	WRONG	RIGHT	WRONG	RIGHT	WRONG	VEHICLES
7/19/63	Broadus Road	Miles City	Billings	invalid	---	results	---	--	--	--
to	"	Billings	Miles City	1451	6	2.10	2.00	691	3	0.43
7/27/63	"	Miles City	Glendive	1400	12	2.16	"	648	6	0.93
	"	Glendive	Miles City	1583	2	2.28	"	694	1	0.14
7/28/63	902 Air Force	Miles City	902 A. F.	1907	0	2.0*	"	954	0	0.00
to	"	902 A. F.	Billings	118	2	2.0*	"	59	1	1.69
8/4/63	"	Billings	902 A. F.	110	2	2.0*	"	55	1	1.82
	"	902 A. F.	Miles City	1902	14	2.0*	"	951	7	0.73
8/18/63	Lima	Lima	Dillon	1935	2	2.06	"	939	1	0.11
to	"	Dillon	Lima	2016	2	2.02	"	998	1	0.10
8/24/63	"	Lima	Idaho	1071	0	2.02	"	530	0	0.00
	"	Idaho	Lima	1168	8	2.03	"	575	4	0.70
8/18/63	Monida	Lima	Monida	535	0	2.04	"	262	0	0.00
to	"	Monida	Idaho	301	0	2.36	"	128	0	0.00
8/24/63	"	Idaho	Monida	312	4	2.22	"	141	2	1.42
	"	Monida	Lima	551	4	2.04	"	270	2	0.74
6/3/63	Sunburst	Sunburst	Shelby	3479	4	2.06	"	1689	2	0.12
to	"	Shelby	Sunburst	3363	2	2.12	"	1586	1	0.06
6/10/63	"	Sunburst	Canada	2141	4	2.02	"	1060	2	0.19
	"	Canada	Sunburst	2150	10	2.04	"	1054	5	0.47
6/11/63	Ulm	Great Falls	Ulm	5604	20	2.01	"	2788	10	0.35
to	"	Ulm	Cascade	1037	4	2.04	"	508	2	0.39
6/18/63	"	Cascade	Ulm	1103	16	2.08	"	530	4	0.75
	"	Ulm	Great Falls	6083	16	2.02	"	3011	4	0.13
8/28/63	Ulm	Great Falls	Ulm	2940	10	2.04	"	1441	5	0.35
to	"	Ulm	Cascade	755	0	2.05	"	368	0	0.00
9/3/63	"	Cascade	Ulm	729	0	2.07	"	352	0	0.00
	"	Ulm	Great Falls	4213	2	2.07	"	2035	1	0.05
6/19/63	Cascade	Ulm	Cascade	4258	10	2.09	"	2037	5	0.25
to	"	Cascade	Ulm	4085	16	2.09	"	1955	8	0.41
6/26/63	"	Cascade	Helena	1809	10	2.09	"	866	5	0.57
	"	Helena	Cascade	2175	72	2.09	"	1041	36	3.43
8/28/63	Cascade	Ulm	Cascade	3768	10	2.09	"	1803	5	0.28
to	"	Cascade	Ulm	3084	22	2.01	"	1534	11	0.72
9/3/63	"	Cascade	Helena	1841	14	2.05	"	898	7	0.78
	"	Helena	Cascade	1854	16	2.07	"	896	8	0.89
6/28/63	N. Deer Lodge	Deer Lodge	Butte	984	14	2.12	"	464	7	1.51
to	"	Butte	Deer Lodge	583	8	2.10	"	278	4	1.44
7/6/63	"	Deer Lodge	Garrison	9385	0	2.12	"	4427	0	0.00
	"	Garrison	Deer Lodge	8622	10	2.08	"	4145	5	0.12
7/12/63	Wibaux	Wibaux	Beach	3455	12	2.17	"	1592	6	0.38
to	"	Beach	Wibaux	3238	6	2.06	"	1572	3	0.19
7/19/63	"	Wibaux	Glendive	4584	2	2.24	"	2046	1	0.05
	"	Glendive	Wibaux	4552	14	2.13	"	2137	7	0.33
7/19/63	Baker Road	Miles City	Billings	2326	10	2.50	"	930	5	0.54
to	"	Billings	Miles City	2141	8	2.27	"	943	4	0.42
7/27/63	"	Miles City	Glendive	5731	0	2.18	"	2629	0	0.00
	"	Glendive	Miles City	5630	4	2.17	"	2595	2	0.77
							TOTAL	59105	194	0.33

*Determined by an interview with Air Force Personnel

TABLE V: DAY & NIGHT PERCENT WRONG-WAY AXLES - 1963

LOCATION	DAY		NIGHT		% WRONG-WAY AXLES	
	Right	Wrong	Right	Wrong	Day	Night
Sunburst	4,613	8	6,520	13	0.17	0.20
Ulm	9,766	21	12,698	33	0.22	0.26
Cascade	9,820	81	13,054	91	0.82	0.70
Deer Lodge	10,519	21	9,055	12	0.20	0.13
Wibaux	7,104	10	8,730	25	0.14	0.29
Baker Road	8,120	12	7,708	11	0.15	0.14
Broadus Road	2,362	19	2,072	8	0.80	0.39
902 Air Force Sqd.	1,789	0	2,248	18	0.00	0.80
Lima	3,019	6	3,171	6	0.20	0.19
Monida	857	0	842	9	0.00	1.07
TOTAL	57,969	178	66,098	226	0.31	0.34

Day: 8:00, 9:00 or 10:00 A.M. to 4:00, 5:00 or 6:00 P.M. = 8 hours
Night: 16 hours